



OPEN ACCESS

EDITED BY

Gianmaria Sannino,
Italian National Agency for New Technologies,
Energy and Sustainable Economic
Development (ENEA), Italy

REVIEWED BY

Aman Srivastava,
Indian Institute of Technology Kharagpur,
India
Ivica Vilbic,
Rudjer Boskovic Institute, Croatia

*CORRESPONDENCE

Federica Borile
✉ federica.borile2@unibo.it

RECEIVED 29 July 2024

ACCEPTED 03 January 2025

PUBLISHED 07 February 2025

CITATION

Borile F, Pinardi N, Lyubartsev V,
Ghani MH, Navarra A, Alessandri J,
Clementi E, Coppini G, Mentaschi L, Verri G,
da Costa VS, Scoccimarro E, Misurale F,
Novellino A and Oddo P (2025) The Eastern
Mediterranean Sea mean sea level decadal
slowdown: the effects of the water budget.
Front. Clim. 7:1472731.
doi: 10.3389/fclim.2025.1472731

COPYRIGHT

© 2025 Borile, Pinardi, Lyubartsev, Ghani,
Navarra, Alessandri, Clementi, Coppini,
Mentaschi, Verri, da Costa, Scoccimarro,
Misureale, Novellino and Oddo. This is an
open-access article distributed under the
terms of the [Creative Commons Attribution
License \(CC BY\)](#). The use, distribution or
reproduction in other forums is permitted,
provided the original author(s) and the
copyright owner(s) are credited and that the
original publication in this journal is cited, in
accordance with accepted academic
practice. No use, distribution or reproduction
is permitted which does not comply with
these terms.

The Eastern Mediterranean Sea mean sea level decadal slowdown: the effects of the water budget

Federica Borile^{1*}, Nadia Pinardi^{1,2}, Vladyslav Lyubartsev²,
Mahmud Hasan Ghani¹, Antonio Navarra^{2,3}, Jacopo Alessandri¹,
Emanuela Clementi², Giovanni Coppini², Lorenzo Mentaschi¹,
Giorgia Verri², Vladimir Santos da Costa², Enrico Scoccimarro²,
Francesco Misurale⁴, Antonio Novellino⁴ and Paolo Oddo¹

¹Department of Physics and Astronomy, University of Bologna, Bologna, Italy, ²CMCC Foundation—Euro-Mediterranean Center on Climate Change, Bologna, Italy, ³Department of Geology, Biology, Ecology and Environmental Sciences, University of Bologna, Bologna, Italy, ⁴ETT SpA, Genova, Italy

This paper analyses the decadal variability of the Mean Sea Level (MSL) trend for the Mediterranean Sea and three subregions using a combination of satellite altimetry, tide gauges and reanalyses datasets for the past 30 years (1993–2022). These estimates indicate a decadal variability of the MSL across the analysed period, and a trend slowdown in the 2013–2022 decade compared to previous periods. While the overall trend remains positive across the Mediterranean basin, regional differences are evident. The Western Mediterranean shows an accelerating trend, consistent with global sea level rise, while the Eastern Mediterranean has experienced a decadal slowdown, particularly in the semi-enclosed Adriatic and Aegean Seas, where negative trends are observed. This slowdown is attributed to the combined effects of changes in the water cycle and the balancing of thermal and haline steric components. A key driver of this trend is increased evaporation, which is not offset by precipitation, runoff, or transport through the Straits. These results underscore the significance of the Mediterranean's water budget in influencing sea level trends and highlight the complexity of modelling and interpreting decadal sea level changes. The findings suggest that continued monitoring and a better understanding of regional water budgets are crucial for refining future projections and developing effective climate adaptation strategies for the Mediterranean coastal areas.

KEYWORDS

Mediterranean Sea, water budget, decadal variability, steric sea level, climate adaptation, mean sea level trend, Mediterranean Sea-Eastern

1 Introduction

The Global Mean Sea Level (GMSL) has been extensively analysed over the past decades as a key indicator of the impact of climate change on coastal regions (IPCC, 2023). Numerous studies confirm a positive GMSL trend over the last century, estimated at 1.6 ± 0.4 mm/year (Hay et al., 2015), with evidence pointing to an acceleration over the last 30 years (Ablain et al., 2019; Dangendorf et al., 2019; Merrifield et al., 2009). However, regional Mean Sea Level (MSL) can be affected by large temporal variability in the ocean circulation and buoyancy forcings, thus influencing the trend from interannual to decadal time scales (Moreira et al.,